

1    Downhole Connector

2  
3    The present invention relates to apparatus and method for  
4    running and setting apparatus in a well bore and in  
5    particular to apparatus and method for setting a liner in  
6    a well bore, where the liner is used as part of the drill  
7    string and is left cemented in place in the well, after  
8    drilling is complete.

9  
10   In drilling and completing well bores it is typical to  
11   insert liner into the well bore. The liner may be  
12   inserted through casing and tied back to provide a  
13   production string in a pre-drilled well bore.  
14   Alternatively the liner may form part of the drill string  
15   and be run into the well bore during drilling. When the  
16   liner reaches its desired location, any tools such as the  
17   drill bit or mud motors may be removed from the string,  
18   and cement is typically passed down the liner to fill the  
19   annulus between the liner and the well bore or casing  
20   wall. The string above the liner is then detached and  
21   removed, leaving a cemented liner within the well bore.

22  
23   Various tools have been developed to releasably attach to  
24   the liner. These are generally termed liner running and

1 setting tools. The tools must also allow for torque to be  
2 transmitted through the liner when a drill bit is located  
3 below the liner. Additionally it has been found  
4 advantageous to rotate and reciprocate the liner during  
5 cementing to distribute the cement more evenly and thus  
6 the tools need to allow for this. Further, some  
7 operations now require the ability to 're-stab' i.e. to  
8 reconnect to the liner after cementing. This procedure is  
9 also advantageous if the tool is used as a connector to  
10 other apparatus than liners e.g. packers.

11  
12 The most basic of these running and setting tools consist  
13 of a screw thread on a setting tool connected to the  
14 drill string engaging a matching thread on a setting  
15 sleeve at the top of the liner. Release is effected by  
16 unscrewing the thread when the liner is cemented. For  
17 drilling applications, these tools typically have a left  
18 hand thread which is releasable by right hand torque.  
19 This is because the drill string has joints connected by  
20 right hand threads, which are rotated clockwise in use.  
21 It was found that setting tools having right hand threads  
22 had make-up torque applied to them during drilling and,  
23 as a result, when the tool was released, by rotating the  
24 drill string anti-clockwise, joints would separate in the  
25 string preferentially to release of the liner.

26  
27 However, as typical setting tools have left hand threads,  
28 torque transmitting mechanisms require to be included in  
29 the tools to allow the liner to rotate with the drill  
30 string and the drill bit. Some tools use spring loaded  
31 dogs or collets on the setting tool to engage  
32 longitudinal slots on the setting sleeve. These matings  
33 allow for relative longitudinal movement between the

1 setting tool and sleeve while circumferentially securing  
2 the two together so that torque can be transmitted  
3 between both. In this way they may be considered as a  
4 clutch since they must be able to be 'declutched' to  
5 release the sleeve from the setting tool. The setting  
6 tool and sleeve will turn together whether the string is  
7 rotated clockwise or anti-clockwise. Due to the  
8 mechanisms and moving parts required, a disadvantage of  
9 these tools is that debris within the well bore can  
10 impede their action, causing the tool to malfunction. A  
11 further disadvantage of many of these tools is that to be  
12 releasable, a drop ball or bomb must be landed on the  
13 tool through the work string. The drop ball, or bomb  
14 blocks all or part of the bore of the liner and therefore  
15 impedes efficient cementing.

16  
17 It is therefore an object of at least one embodiment of  
18 the present invention to provide a downhole releasable  
19 coupling through which torque can be transmitted without  
20 make-up torque being applied to screw threads in the  
21 coupling.

22  
23 It is a further object of at least one embodiment of the  
24 present invention to provide a drilling liner system for  
25 use on a drill string through which torque can be  
26 transmitted without make-up torque being applied to screw  
27 threads in the coupling.

28  
29 According to a first aspect of the present invention  
30 there is provided a downhole releasable coupling, the  
31 coupling comprising a first substantially tubular member  
32 having a bore therethrough, a first screw thread around  
33 an outer surface thereof, one or more raised portions

1 arranged circumferentially on the outer surface, the  
2 raised portions defining a first face surrounding the  
3 member and substantially perpendicular to the outer  
4 surface, the first face being directed toward the first  
5 screw thread, the first face having a plurality of first  
6 projections, each first projection having a substantially  
7 first straight portion arranged parallel to the bore and  
8 a first sloping portion, joining an apex of the first  
9 projection to a base of an adjacent projection; and a  
10 second tubular member having a bore therethrough, a  
11 second screw thread around an inner surface thereof, one  
12 or more raised portions arranged circumferentially on an  
13 outer surface thereof, the raised portions defining a  
14 second face surrounding the member and substantially  
15 perpendicular to the outer surface, the second face being  
16 at an end of the member, the second face having a  
17 plurality of second projections, each second projection  
18 having a substantially second straight portion arranged  
19 parallel to the bore and a second sloping portion,  
20 joining an apex of the second projection to a base of an  
21 adjacent projection; wherein the first tubular member  
22 slides within the second tubular member, the first and  
23 second screw threads mate and on part engagement of the  
24 screw threads, the first and second straight portions can  
25 meet to thereby transfer torque when a member is rotated  
26 in the direction of the screw threads.

27

28 The projections may be considered as teeth on a ratchet.  
29 In this way opposing teeth abut so that torque is  
30 transferred between the members in a uni-directional  
31 manner. As the projections meet before the screw threads  
32 end, there is no make-up torque applied to the threads.  
33 As soon as the direction of rotation is reversed the

1 members move relative to each other and unscrew. This  
2 provides rapid release, as there is no make-up torque to  
3 overcome before movement can occur.

4

5 Preferably the screw threads are right hand screw  
6 threads. In this way, torque can be transmitted on  
7 rotation of a work string.

8

9 Advantageously the screw threads are multiple start  
10 threads. Preferably the screw threads are double start  
11 screw threads. Preferably also the screw threads are  
12 square. Additionally the screw threads may have generous  
13 lead in edges so that the coupling can be re-engaged  
14 easily.

15

16 Preferably the tubular members are initially releasably  
17 attached to each other by a shearing means. Preferably  
18 the shearing means is by one or more shear pins. The  
19 shear pins may be arranged through apertures on the  
20 second member and rest in pockets in the outer surface of  
21 the first member. Advantageously the apertures and the  
22 pockets align when the first and second straight portions  
23 abut. The use of shearing means allows a predetermined  
24 torque value to be set at which decoupling will occur.

25

26 Additionally at least one o-ring may be arranged at  
27 either end of the screw thread circumferentially around  
28 the tubular member. This prevents the ingress of debris  
29 to the thread. Preferably the o-rings are retained in  
30 circumferential grooves on the outer surface of the first  
31 tubular member.

32

1 An embodiment may comprise four raised portions on each  
2 tubular member; each face providing two equidistantly  
3 spaced projections; four apertures being arranged through  
4 the raised portions of the second tubular; shear pins  
5 being located through each aperture into four pockets on  
6 the outer surface of the first tubular; and an o-ring  
7 located into a groove at each end of the screw thread of  
8 the first tubular member.

9  
10 According to a second aspect of the present invention  
11 there is provided a drilling liner system comprising a  
12 running tool having a substantially cylindrical first  
13 body and a first bore therethrough, the first body having  
14 an end adapted for connection to a drill string, and a  
15 setting sleeve having a substantially cylindrical second  
16 body and a second bore therethrough, the second body  
17 having an end adapted for connection to a liner, wherein  
18 the running tool and the setting sleeve couple via a  
19 detachable coupling according to the first aspect.

20  
21 Preferably the running tool includes the first tubular  
22 and the setting sleeve includes the second tubular  
23 member.

24  
25 Preferably the bores align to provide a continuous  
26 central bore through the system.

27  
28 More preferably the screw threads are right hand screw  
29 threads. This arrangement allows torque to be transmitted  
30 by rotation of the drill string. Further the system can  
31 be reciprocated and rotated as it will simply follow the  
32 motion of the drill string until the setting sleeve is  
33 held in a fixed position.

1  
2 Preferably the running tool includes one or more first  
3 radial outlets arranged circumferentially around the  
4 first body, the setting sleeve includes one or more  
5 second radial outlets arranged circumferentially around  
6 the second body, and in a first position the first and  
7 second radial outlets are aligned and fluid can pass  
8 radially from the system. Alignment is effected by moving  
9 the running tool and setting sleeve relative to each  
10 other by rotation of one against the other to relocate on  
11 the screw thread. This provides selective radial fluid  
12 flow from the tool which can be used to distribute cement  
13 more effectively and wash out the well bore.

14  
15 Preferably there are four radial ports in each body. More  
16 preferably the first position occurs when the first and  
17 second screw threads are partially engaged.

18  
19 Optionally the system may further comprise a seal stem,  
20 the stem having a substantially cylindrical third body  
21 with a third bore therethrough, a third screw thread on  
22 an outer surface thereof for engagement to the second  
23 screw thread, and a polished end distal to the screw  
24 thread. Once the running tool is decoupled from the  
25 setting sleeve, the stem can be connected to the setting  
26 sleeve to provide a polished bore receptacle to the  
27 setting sleeve for tie-back purposes.

28  
29 According to a third aspect of the present invention,  
30 there is provided a method of setting a liner in a well  
31 bore, the method comprising the steps;

32

- 1 (a) providing a drilling liner system according to the
- 2 second aspect;
- 3 (b) connecting the running tool and setting sleeve by
- 4 engaging the screw threads until the first and
- 5 second straight portions meet;
- 6 (c) connecting the running tool to a drill string and
- 7 the setting sleeve to a liner;
- 8 (d) transmitting torque to the liner by rotating the
- 9 drill string in a first direction;
- 10 (e) cementing the liner in place by introducing cement
- 11 slurry axially into the bore, to allow the slurry to
- 12 exit the liner and locate between the liner and the
- 13 well bore; and
- 14 (f) rotating the drill string in a reverse direction
- 15 until the screw threads disengage; and
- 16 (g) removing the running tool from the well bore.
- 17
- 18 Preferably the first direction is right hand rotation.
- 19
- 20 The method may include the step of removing an assembly
- 21 from the well bore through the liner when the system is
- 22 connected to the liner. The assembly may be a drilling
- 23 assembly or a mud motor assembly.
- 24
- 25 Preferably the method includes the step of shearing the
- 26 shearing means when the drill string is rotated in the
- 27 reverse direction.
- 28
- 29 Preferably also the method includes the step of aligning
- 30 the radial ports to expel fluid or cement from the
- 31 system.
- 32



1 Preferably the method includes the step of rotating and  
2 reciprocating the system on the drill string during  
3 cementing.

4

5 Preferably the method includes the following steps:

- 6 (a) following rotation in the first direction, noting a  
7 first circulation pressure in the well bore;  
8 (b) applying liner weight to bottom of well and partly  
9 releasing the running tool from the setting sleeve  
10 to shear the shear screws and align the radial  
11 ports;  
12 (c) confirming that circulation pressure has dropped  
13 from the first circulation pressure;  
14 (d) on pressure loss rotating the drill string until the  
15 straight portions meet; and  
16 (e) confirming circulation pressure has returned to  
17 first circulation pressure.

18 These steps provide confirmation that, firstly, partial  
19 release has occurred and, secondly, that the running tool  
20 can be released after cementing.

21

22 Embodiments of the present invention will now be given,  
23 by way of example only, with reference to the  
24 accompanying Figures of which:

25

26 Figure 1 is a part cross-section of the view of the  
27 downhole connector according to an embodiment of the  
28 present invention where Figure 1(a) illustrates the  
29 first tubular member and Figure 1(b) illustrates the  
30 second tubular member to be coupled thereto;

31

Figure 2 is a schematic representation of the circumferential profile of a portion of the connector of Figure 1;

Figure 3 is a schematic representation of a drilling liner system according to an embodiment of the present invention, illustrated in (a) run in position, (b) partial release or by-pass position and (c) released position; and

Figure 4 is a part cross-sectional view of a liner stem for use in the drilling liner system of Figure 3.

Referring initially to Figure 1 of the drawings, there is provided a releasable coupling, generally indicated by reference number 10, according to a first embodiment of the present invention. Coupling 10 comprises two parts, the first part being an upper tubular member 12 and the second being a lower tubular member 14 shown in Figures 1(a) and (b) respectively. The upper 12 and lower 14 tubular members are releasably coupled as described hereinafter.

The upper tubular member 12 comprises a cylindrical body 16 and central bore 18 therethrough. At the upper end 20 is located a downhole attachment 22 for connecting the tubular member 12 to a tool or workstring located above. Typically downhole attachment 22 would be a box section as is commonly known in the art. Toward the upper end 20 of tubular member 12 is provided a raised portion 24 on the outer surface 26 of the tubular member 12. Raised portion 24 comprises four substantially longitudinal

1 sections 28 lying longitudinally on the outer surface 26.  
2 Longitudinal portions 28 are arranged circumferentially  
3 around the body 16.

4  
5 Working towards a lower end 30 of the member 12 there is  
6 next located pockets 32. In the embodiment shown there  
7 are four pockets 32 arranged circumferentially on the  
8 outer surface 26 of the body 16. Pockets 32 are recesses  
9 into which shear screws (not shown) may engage. Below  
10 the pockets 32 lies an annular groove 34 into which an O-  
11 ring 36 is located. Groove 34 preferably has edges which  
12 taper towards the bore 18. The O-ring 36 seals a screw  
13 portion 38 of the member 12 from the downhole environment  
14 in use.

15  
16 Screw portion 38 is a double start screw thread formed on  
17 the outer surface 26 of the body 16. The screw thread is  
18 a square screw thread and is a right hand screw thread.  
19 Below the screw portion 38 lies three annular grooves 40  
20 into which three further seals in the form of O-rings 42  
21 locate. O-rings 42 provide the same advantages as O-  
22 rings 36 and together they can seal off the screw thread  
23 portion 38.

24  
25 Finally, below the grooves 40 are located radial ports  
26 44. Four radial ports 44 are arranged circumferentially  
27 around the body 16 of the member 12. Each port 44  
28 provides a connection from the bore 18 of the member  
29 through the wall 46 of the member 12 to the outer surface  
30 26.

31 Lower tubular member 14 comprises a cylindrical body 48  
32 having an internal bore 50 therethrough. At a lower end  
33 52 of the member 14 is arranged a downhole attachment 54

1 to couple the member 14 to a tool or workstring arranged  
2 below the member 14. It will be understood that  
3 attachment 54 will typically be a pin section as is known  
4 in the art.

5  
6 In bore 50 is arranged an inner surface 56. Inner  
7 surface 56 comprises a screw thread portion 58 whose  
8 threads match and co-operate with the screw thread  
9 portion 38 of tubular member 12. In addition, four  
10 radial ports 60 are arranged circumferentially on the  
11 inner surface 56 to provide a passage for fluid from the  
12 bore 50 to the outer surface 62 of the member 14. There  
13 are four radial ports 60 arranged circumferentially  
14 around the body 48.

15  
16 On the outer surface 62 of the member 14 are located four  
17 raised portions 64. The raised portions 64 are arranged  
18 circumferentially on the body 48. Upper ends 66 of the  
19 raised portions extend beyond the upper end 68 of the  
20 member 14. Arranged on each raised portion 64 is an  
21 aperture 70. Aperture 70 provides a connection from the  
22 outer surface 62 to the inner surface 56 of the body 48.  
23 Aperture 70 is used to fit a shear screw (not shown)  
24 through to the pocket 32 of the member 12. It will be  
25 appreciated that any number of aperture/pocket  
26 combinations can be used and that the selection of the  
27 shear screw size and material, together with the number  
28 used will determine the torque which can be applied  
29 between the upper 12 and lower 14 tubular members to  
30 effect a de-coupling.

31

32 Reference is now made to Figure 2 of the drawings which  
33 provides in two parts, (a) and (b), the raised portions

1 24,64 of the tubular members 12 and 14 respectively.  
2 Figure 2(a) illustrates the raised portion 24 in  
3 longitudinal profile which may be described as a  
4 developed circumference. The four longitudinal portions  
5 28a-d provide an edge 72 which faces the pockets 32 on  
6 the body 16. Edge 72 can be considered as providing a  
7 face 74 perpendicular to the outer surface 26 of the  
8 member 12. Face 74 includes two projections 76a,b. Each  
9 projection has a straight portion 78a,b which lies  
10 longitudinally with the portions 28 and parallel with the  
11 bore 18. Each straight portion 78 arrives at an apex  
12 80a,b from a base 82a,b. Accordingly there are two  
13 sloping sections 84a,b which join the apexes 80a,b to the  
14 bases 82a,b. It will be noted that in this embodiment there  
15 are two projections 76a,b originating on two portions 28.  
16 It will be appreciated however, that any number of raised  
17 portions will be designed into the coupling 10.

18  
19 Referring now to Figure 2(b), there is shown the upper  
20 end 68 of member 14 having a complimentary matching face  
21 86 to that of face 74. Face 86 comprises two projections  
22 88a,b. The projections each have a straight portion  
23 90a,b arranged parallel to the bore 50. Each straight  
24 section 90a,b also comprises an apex 92a,b and a base  
25 94a,b. Again adjacent projections 88a,b are joined by a  
26 sloping surface 96a,b which connect the adjoining apexes  
27 92a,b with bases 94a,b.

28  
29 Reference is now made to Figure 3 of the drawings which  
30 illustrates in the three steps, shown as (a), (b) and  
31 (c), the tool in use. In this embodiment the tool is  
32 described with reference to a drilling liner system with  
33 a coupling 10 being part of a drill string (not shown).

1 Like parts to those of Figures 1 and 2 have been given  
2 the same reference numerals to aid clarity. Thus in use,  
3 referring initially to Figure 3(a), coupling 10 is in a  
4 made-up configuration. This will be the configuration  
5 used on run in of a drilling liner system, generally  
6 indicated by reference numeral 100, into a well bore (not  
7 shown). The upper tubular member 12 will now be  
8 recognised as a liner running tool while the lower  
9 tubular member will be recognised as a liner setting  
10 sleeve.

11

12 In this configuration the upper tubular member 12 is  
13 connected to an upper section of drill string by use of  
14 the box section 22 and the lower tubular member 14 is  
15 connected to a lower portion of drill string through the  
16 pin section at 54. The tubular members 12, 14 are  
17 connected by inserting upper tubular member 12 into lower  
18 tubular member 14 and engaging the screw threads 38, 58.  
19 The threads are fully engaged until such point that the  
20 straight portions 78, 90 abut and prevent any further  
21 rotational movement of one tubular member independent of  
22 the other tubular member. Thus any torque applied to the  
23 upper tubular member 12 in a clockwise direction will  
24 cause the lower tubular member 14 to rotate with the  
25 upper tubular member 12. In this way torque is  
26 transmitted through the system 100.

27

28 The upper and lower tubular members 12, 14 are further  
29 secured via shear screws 98, located through the aperture  
30 70 of the lower tubular member 14 and into a pocket 32 of  
31 the upper tubular member 12. It will be appreciated that  
32 the shear screws 98 can be selected to predetermine the  
33 torque applied to the coupling 10 at which they will

1 shear and detach the coupling 10 as described  
2 hereinafter.

3  
4 It should be noted that a clear bore 102 is provided through  
5 the system 100, as a passage from bore 18 through bore  
6 50. Additionally seals 36,42 isolate the screw threads  
7 38,58 from the passage of fluid through the bore 102.  
8 Fluid in the drill string will pass through the bore 102  
9 as the radial ports 44,60 in each tubular member 12,14  
10 respectively are misaligned. Thus while the drill string  
11 is rotated in a typical clockwise direction the coupling  
12 10 is attached and the drill liner system 100 will act as  
13 if part of the drill string, transferring torque to any  
14 components or tools attached below the system 100.

15  
16 As shown in Figure 3(b) to detach the system the upper  
17 tubular member 12 is rotated anti-clockwise. While it is  
18 known that rotating the drill string in an anti-clockwise  
19 direction risks releasing tubing joints within the drill  
20 string, these tubing joints will naturally have made-up  
21 torque applied to them. By virtue of the straight  
22 portions 78,90 meeting on the upper and lower tubular  
23 members 12,14, torque is transferred through these  
24 surfaces and thus there is no made-up torque on the  
25 threads and any anti-clockwise rotation will immediately  
26 release the faces 78,90 from each other. Continuous  
27 turning of the upper tubular member 12 will cause the  
28 screw threads 38,58 to unscrew and thereby move the upper  
29 tubular member 12 away from lower tubular member 14.  
30

31 On turning the drill string anti-clockwise it is the  
32 shear screws 98 which will shear at a predetermined torque and  
33 the coupling 10 will detach. As the shear screws 98

1 shear, the straight portions 78,90 will come away from  
2 each other and by virtue of the screw threads, the  
3 tubular members are unscrewed from each other.

4  
5 In the preferred embodiment, as shown in Figure 3(b),  
6 anti-clockwise rotation of the upper member 12 relative  
7 to the lower member 14 by only two turns causes the  
8 radial ports 44,60 to become aligned. In aligning the  
9 radial ports 44,60 fluid flow can pass from the bore 102  
10 to the annulus 104 outside the system 100. Such movement  
11 of fluid will cause a change in fluid pressure at the top  
12 of the well bore which can be noted by the operators.  
13 Notification of such a pressure change informs the  
14 operators that the coupling 10 has detached successfully.  
15 At this point fluid could be pumped down the bore 102 to  
16 be expelled through the radial ports 44,60 to provide for  
17 a cementing or cleaning action within the annulus 104.

18  
19 Further rotation of the upper tubular member 12 relative  
20 to the lower tubular member 14 in the anti-clockwise  
21 direction will eventually cause the screw threads 38,58  
22 to be completely released from each other and accordingly  
23 the upper tubular member 12 becomes entirely detached  
24 from the lower tubular member 14. In this configuration  
25 the lower tubular member 14 may be left within a well  
26 bore, while the upper tubular member 12 can be removed  
27 from the well bore upon the drill string.

28  
29 It should also be noted that simply by reinserting the  
30 upper tubular member 12 into the lower tubular member 14  
31 the coupling 10 can be reattached as the threads 38 have  
32 a long lead into the threads 58. Thus rotation of the  
33 drill string, including the upper tubular 12 into the



1 lower tubular member 14 will cause the coupling to be  
2 reattached. The reattachment can be made up to the point  
3 where the sloping surfaces 78,90 meeting. In this  
4 configuration the lower tubular member 14 may also be  
5 removed from the well bore.

6  
7 The embodiment described in Figure 3 is ideally suited to  
8 be used for setting a liner in a well bore. The method  
9 of setting such a liner in a well bore would be to run a  
10 liner with a desired bottom hole assembly. Connect the  
11 drilling line system 100 to the drill pipe and run in the  
12 well bore on the drill pipe. The bottom hole assembly  
13 would include the necessary drill bit and drilling  
14 assembly and thus by rotation of the upper tubular member  
15 12 transferring torque to the lower tubular member 14,  
16 the hole may be drilled by rotation of the drill string.  
17 This is achieved by right hand rotation as required.

18  
19 With the bottom hole assembly of the bottom of the well,  
20 fluid is circulated at a fixed rate, such as 5 bbls/min  
21 and the circulation pressure noted. At this point the  
22 mudpumps within the well are stopped. If the drill bit  
23 and the drilling assembly is to be retrieved with the mud  
24 motor, these portions can be fed through the bore 102 to  
25 the surface, typically by insertion of a wire line  
26 through the bore 102. Next the entire liner weight is  
27 applied to the bottom of the well in order to achieve the  
28 neutral point of the drilling liner system 100. Such a  
29 neutral point allows the drill string to be rotated in a  
30 left hand rotation in order that the shear screws shear  
31 and the ports 44,60 align. This occurs by rotation of two  
32 left hand rotations on the drill pipe.

1 In this partially engaged position, shown in Figure 3(b),  
2 circulation is restarted at the previous flow rate and  
3 the circulation pressure will now be reduced to indicate  
4 that the ports 44,60 have aligned. The system 100 is open  
5 to allow fluid to pass between the bore 102 and the  
6 annulus 104. This reduction in circulation pressure  
7 further shows that partial release has occurred and  
8 indicates that the coupling 10 can be released after  
9 cementing.

10

11 When the pressure loss is noted, the mud pumps are  
12 stopped and the upper and lower members 12,14 are re-  
13 engaged by applying two right hand rotations to the  
14 system 100. Confirmation that the ports 44,60 are now  
15 closed by being misaligned is confirmed by re-  
16 establishing the previous circulation rate and confirming  
17 that the pressure has returned to the first pressure  
18 noted.

19

20 Cementation of the liner can now be performed by  
21 injecting cement through the bore 102. It should be  
22 noted that the system 100 can be advantageously  
23 reciprocated and/or rotated so that the liner can be  
24 reciprocated and/or rotated during the cementing process  
25 to enhance the cementing operation. A displacement  
26 wiper-plug is then launched through the bore 102 to  
27 displace cement through the centre of the bore 102.

28

29 The entire liner weight is then re-applied to the bottom  
30 and eight left hand rotations are applied to the coupling  
31 10. This releases the upper tubular member 12 from the  
32 lower tubular member 14 and the upper tubular member is  
33 pulled clear of the lower tubular member and returned to .

1 the surface. Reverse circulation can be used to remove  
2 excess cement as required prior to the string being  
3 pulled out of the hole.  
4  
5 A further feature of the embodiment herein described, is  
6 that of the provision of a liner seal stem if required.  
7 Figure 4 shows a suitable liner seal stem, generally  
8 indicated by reference numeral 106, which may be used  
9 with the liner system 100 described hereinbefore.  
10  
11 The seal stem 106 comprises a cylindrical body 108 having  
12 a bore 110 therethrough. At a base 112 of the stem 106  
13 are located annular grooves 114 into which O-ring seals  
14 116 are incorporated. The outer diameter 118 of a lower  
15 portion of the stem 106 is sized such that it can fit  
16 within the bore 50 of the lower tubular member 14.  
17  
18 When inserted into the lower tubular member 14 the O-  
19 rings 116 will seal against the inner surface 56 of the  
20 member 14, just below the radial port 60. Sloping  
21 portions 120 on the outer surface 118 will meet with the  
22 face 74 at the upper end 68 of the member 14. This will  
23 provide an upper section 122 of the stem 106 at whose  
24 distal end 124 is located a polished bore receptacle 126.  
25  
26 Thus when the stem 106 is inserted in the lower tubular  
27 member 14, i.e. the setting sleeve, for the drilling  
28 liner system 100 the stem 106 will provide a polished  
29 bore receptacle 126 above the cemented liner.  
30  
31 Various modifications made by made to the invention  
32 herein described without departing from the scope  
33 thereof. For example, the number of projections located

1 on each of the tubular members may be varied as long as  
2 it is noted that a substantial meeting of the straight  
3 portions will occur on rotation of the two members  
4 relative to each other. Further additional seals may be  
5 provided around the radial ports to further prevent the  
6 ingress of fluids to the screw threads in use.  
7 Additionally while the system has primarily described the  
8 use of the tool for cementing purposed it will be  
9 recognised that the alignment of the radial ports  
10 provides a passage both for cement and for cleaning fluid  
11 from the central bore to the annulus and indeed walls or  
12 casing within a well bore.

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